The PROGRESSIVE FISH CULTURIST

JULY–OCTOBER 1939

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF FISHERIES
WASHINGTON

THE PROGRESSIVE FISH CULTURIST

A SERIAL memorandum published occasionally for the advancement of fish culture and fishery management in fresh waters.

TABLE OF CONTENTS

	Page
FISH AND Fishing Waters in Glacier Park, by A. S. Hazzard	1
HATCHERIES, by Richard Paget	7
SOME EXPERIMENTS on Use of Beef Liver, Seal Meal, Salmon Meal, Apple Flour in Diet of Young Chinook Salmon, by L. R. Donaldson and Fred J. Foster	12
PERFECTION in Hatchery Intakes, by A. H. Dinsmore	16
TRANSPORTATION of Channel Catfish Eggs and Fry, by Charles L. Fuqua	19
BULB SIPHON Egg Picker, by Roger E. Burrows	22
NOTICE to Subscribers	24
GOOD TOOLS Help to Make Good Fish Culturists, by Robert Fortney	25
PROGRESSIVE FISH CULTURIST and Reorganization	27
NOTES ON Control of Weeds in Ponds, by Claude Lydell	28
A NARROW Escape, by Charles Minor Blackford	30
NOTES and News:	
Trout Planting in Alaskan Lakes	31
T.V.A. Fishery Operations	33
Progress in Anti-Pollution Legislation	34
COMMENTS From Our Readers:	
Gloves for Winter Use in Taking Bottom Samples, by Eugene W. Surber	35
TIME Magazine Article, by J. Q. McGee	35
REVIEWS:	
Cooper: Biological Survey of 31 Lakes and Ponds of Upper Saco River and Sebago Lake Drainage Systems in Maine, by Elmer Higgins	36
Moore: Biological Survey of Fresh Waters of Long Island, by Elmer Higgins	36

Editor

Elmer Higgins, Chief, Division of Scientific Inquiry, U. S. Bureau of Fisheries

Associate Editors

Dr. H. S. Davis, In Charge, Aquicultural Investigations, U. S. Bureau of Fisheries
Professor Lauren R. Donaldson, School of Fisheries, University of Washington
Dr. A. S. Hazzard, Institute for Fisheries Research, Michigan Conservation Department
M. C. James, Assistant Chief, Division of Fish Culture, U. S. Bureau of Fisheries
Dr. A. H. Wiebe, Biological Readjustment Unit, Tennessee Valley Authority
Dr. Louis E. Wolf, New York Department of Conservation

APPLICATIONS for this memo, which is distributed free on regular mailing lists, should be addressed to the Commissioner of Fisheries, Washington, D. C. Contributions for publication are welcome.

While a certain amount of editorial selection of material is exercised, the Bureau of Fisheries does not necessarily endorse and is not responsible for the statement of facts nor for views and opinions published herein.

The PROGRESSIVE FISH CULTURIST
News and Views from many Sources on Practical Hatchery Problems

ISSUED BY THE

United States Department of the Interior---------- Harold L. Ickes, Secretary
Bureau of Fisheries---------- Charles E. Jackson, Acting Commissioner

Memorandum I-131 Washington, D. C. July-October 1939 No. 46

FISH AND FISHING WATERS IN GLACIER PARK

By A. S. Hazzard
Director, Institute for Fisheries Research
Ann Arbor, Michigan

DURING THE SUMMERS of 1932 and 1934 a survey was made of the lakes and streams of Glacier Park to determine conditions for fish life and to outline plans for fisheries management in this unique area.

Field parties made up of fisheries biologists visited all of the streams and lakes accessible by road or horse trail and in addition a few of the primitive waters which could be reached only on foot. The survey was conducted by the U. S. Bureau of Fisheries with assistance from the National Park Service.

No formal report of the work has been published, but the Bureau has authorized preparation of the following popular account of the data secured.

THE STREAMS

The streams of Glacier Park are, as a whole, disappointing to the angler. This is due to a number of causes. Except for the branches of the Flathead River, the streams are mainly small and extremely rapid. The many beautiful waterfalls and cascades seen everywhere in the park are evidence of this. While adding to the attractiveness of the park they do not provide very good homes for trout. The falls prevent free movement of the fish up and downstream and the swift water furnishes very few resting places for fish.

Many of the streams dry up entirely during the winter months, when the glaciers and snow banks which feed them cease to melt. This probably explains why such waters as the Two Medicine River above the middle lake and upper McDonald Creek, though ideal in appearance during the summer, do not carry a good stock of trout. But there are other reasons. Some glacier fed streams carry quantities of rock flour which makes them perpetually roily, preventing the proper development of fish food. Furthermore, and this is extremely important, most of the streams in the park have been found to be too cold to produce good crops of trout. Although this may sound paradoxical, it has been determined that trout do not grow well unless the water temperature ranges from 55° to 65° F. during the summer months. Many streams were found which never reached 55° F. even during the warmest days in summer. A good example is Cut Bank Creek above the Chalet. Only in the beaver ponds and immediately below them does the stream yield any trout worth fishing for.

Another factor which probably makes for poor trout production in streams is the character of the soil through which they flow. Fed by the pure water from snowfields and glacial lakes, they contain very little mineral and organic matter essential to the growth of fish food organisms. Only in the lower reaches do these streams have the proper richness to support the algae which supply the food upon which aquatic insects depend and which in turn make up the staple diet of trout.

Our survey concluded that these are the reasons why the streams of Glacier park, though adding much to the beauty of the area, provide little in the way of fishing. Planting trout in the majority of these waters would obviously do no good nor is there any other practicable way in which the streams can be improved. The lower ends of the larger streams are worthy of some attention, as are the branches of the Flathead River. In these the cutthroat, including the blueback, the Dolly Varden and on the eastern slope the eastern brook trout will continue to furnish some fishing to the angler who does not care for lakes.

THE LAKES

It is in the numerous and beautiful lakes in the park that the best conditions for trout and other game fish are found. Nowhere have we seen a greater variety of lakes than in Glacier. The range extends from small, permanently ice-filled lakes in the glacial cirques high in the mountains to over-rich, weed-filled lakes in the lowland. In between these extremes, neither of which is suitable for fish, is a great range of conditions. In Iceberg Lake, although open water is present on part of the lake during August, the temperature at the surface was only 42° and no sign of plant or animal life could be found. Ptarmigan Lake is at an even greater elevation (6,550 feet) but the glacial cirque in which it lies has a southern exposure and consequently the water warms more rapidly. A few cutthroat trout can find a living in such a lake and reach a fair size.

In general, however, the lower lakes are the best fishing lakes and this is due to the factors mentioned in the discussion of streams. They are generally shallower and warmer and have larger drainage basins than the higher lakes. The soil at lower elevations is richer and the waters consequently produce more food.

The lakes of the park produce the fishing because here the water is spread out and warms rapidly in the shallows and at the surface during the

Lake McDonald, one of the largest and most beautiful lakes in Glacier Park, yields some 40-pound Mackinaws or Dolly Vardens but is less productive than smaller, shallower lakes.

summer even in the higher lakes. Food is produced in astonishing quantity during the brief period of open water and even under the ice our nets took quantities of blood-red water fleas of remarkable size. In the bottom mud, even at depths of 50 or 60 feet, the clamshell Ekman dredge brought up fair samples of midge larvae or blood-worms. Trout feed on these as they swim up to transform into small, mosquito-like flies or upon the adult flies when they light on the water to deposit their eggs. Along the shores, under rocks and logs in many lakes were fresh-water shrimp often

in goodly numbers, and wherever these were found the cutthroat and eastern brook (though not the rainbow) trout were invariably fat and vigorous. The wide expanse of lake surface also acts as a collector of terrestrial insect food - the beetles, ants and various flies which have no part of their life cycle in water but which drop there by accident. Stomach examination of trout from lakes demonstrates the importance of this terrestrial food. Forty-three per cent of the cutthroat, 61 per cent of the eastern brook trout, 33 per cent of the rainbow, 10 per cent of the Dolly Varden and 70 per cent of the grayling contained land insects. These insects which fall on the water by accident made up from four to 45 per cent of the total food in the stomachs.

In general, the shallower lakes in the park were found to be the most productive. The deep, clear type of lake having a very limited amount of shallow water, such as McDonald Lake, is beautiful to the eye but does not provide the fishing that is found in the shallower lakes such as Red Eagle or Swiftcurrent. We believe this is due in part to the lower food production of deep water as well as to other factors associated with large, clear water lakes having little shoal, relatively unproductive bottom and which are subject to strong wind action.

The clarity of Glacier Park lakes is remarkable in the extreme. The Secchi disk, a white enamelled plate about six inches in diameter, used by the survey to determine water transparency, could be seen in many waters at depths of from 40 to 50 feet. In McDonald Lake, late in the summer, the disk was still faintly visible at the astonishing depth of 72 feet. Such clear water is beautiful in appearance but its clearness indicates a scarcity of organic matter and fish food.

FISH AND FISHING

The fish fauna of Glacier Park is extremely limited. Only 23 species of fish were found by the survey or have been reported, and of these at least three - the rainbow, eastern brook trout, and Lake Superior whitefish - were undoubtedly introduced. The game fish are the native blackspotted or cutthroat trout (two subspecies), the introduced rainbow and eastern brook trout, the Dolly Varden or bull trout, the Mackinaw or lake trout, the Montana grayling (which may have been native to certain park waters), the Rocky Mountain whitefish and the northern pike. The landlocked form of the sockeye salmon called the little redfish or silver trout has been planted in Swiftcurrent Lake and adults ready to spawn were found there in 1932. Whether this species has been permanently established in this lake is not known. No trace of the California golden trout planted in a few of the high lakes could be found by the survey. Three or four species of suckers, five species of minnows (including the squawfish, which reaches a weight of four or five pounds), two species of sculpins, a small whitefish (which never exceeds six inches in length) and the ling (the only representative of the cod family found in fresh waters) complete the list of fishes in the park.

This number of species seems small when it is remembered that three major drainage systems head in Glacier Park, but the cold water and presence of many high falls have undoubtedly restricted the natural distribution of fish in this area. In fact, the majority of the lakes on the east side of the park and a number on the west were originally barren of fish life because falls in the course of the principal streams prevented access to the waters above. Many of the lakes have been planted with trout and now furnish good fishing.

Two Medicine Lake furnishes very dependable brook trout fishing.

Cutthroat fishing: - Some of the finest fishing in the park is for the native black-spotted or cutthroat trout. This is the dominant game fish of the area and is particularly well adapted to the low temperatures common to most of the waters. Cutthroats up to six pounds in weight have been taken in Red Eagle and Hidden Lakes. While the larger fish are generally caught by trolling with fly and spinner or on spoons, they rise to a dry fly when insects are on the water. Unusually beautiful specimens of this native fish were caught in the dark waters of Howe Lake. Since this species, like the rainbow and grayling, spawns in the early summer

in the higher waters, few are caught during June and early July. Cutthroats are at their best in late summer and early fall.

Eastern brook fishing: - Brooks have been introduced into a number of lakes on the eastern side of the park and in Lake Ellen Wilson on the west side. In the majority of waters they do well and are able to maintain themselves by natural reproduction. Middle and Lower Two Medicine Lakes furnish very dependable brook trout fishing, as does Swiftcurrent Lake also. Wet flies or spinners are required until the insects appear, but after that it is a poor fisherman indeed who cannot take a nice catch of brooks on flies if he is persistent and knows the waters. In one lake high in the Bighorn Basin, these brook trout are small but very abundant. Conditions for spawning in this little lake are ideal.

The rainbow has been introduced to the park waters and is doing well in the lower lakes. In the higher lakes, such as Gunsight and Upper Two Medicine, these trout become thin after spawning and apparently never recover condition even though food may be fairly abundant. For this reason planting with this species should be confined to the lower, warmer lakes.

Lake trout fishing: - Glenn and Crossley Lakes provide the best lake for Mackinaw trolling in the park, although some good catches are taken at times in St. Mary's Lake. While surveying the Two Medicine drainage our party received a report that Mackinaw had been planted in the Lower Two Medicine Lake a number of years previously. To check up on this report a small, experimental gill net (used to sample fish populations) was set overnight. When we lifted this net the following morning, hauling it over the side of our shaky rubber boat, we were astonished to see a 16-pound Mackinaw in the meshes. Three others of large size were taken but no small ones, indicating that this species does not spawn successfully although some of the planting had survived and grown fat on the numerous whitefish and suckers in the lake.

Grayling fishing: - The south fork of the Belly River and Elizabeth Lake yield some grayling to those who are able to make the difficult trip. Morans Bath Tub (now called Swiftcurrent Ridge Lake) was planted with eyed eggs of grayling years ago. The planting was a success and the grayling did well but have not reproduced because of the lack of any inlet or outlet stream. In recent years suckers and minnows had apparently been introduced accidentally by fishermen who probably brought them in as bait (in violation of the park rules). In 1934 grayling were extremely scarce and were hardly more than skin and bones - apparently unable to endure the competition. This is a clear though deplorable example of the need for preventing the use of live bait in park waters.

Other fishing: - To the easterner, the catching of a Dolly Varden or bull trout will probably be an interesting experience. Cracker Lake is almost certain to yield some small specimens on flies, while fish up to eight or ten pounds can occasionally be taken by trolling in McDonald Lake or by the use of spinners and worms or minnows in the Flathead River. These fish begin to work up the smaller streams to spawn during late August and early September. Their fight is stubborn but not spectacular and the flesh is inferior to other trout.

FISH CULTURAL OPERATIONS

The U. S. Bureau of Fisheries operates a hatchery and rearing pond at Glacier Park village and in cooperation with the National Park Service plants on the average about a million fish each year. The majority of these are trout, although grayling are stocked in certain waters. The construction of a more adequate cultural station for the park waters is now underway on the west side and should supply better stock for future plantings.

Many of the waters in Glacier Park are well provided with spawning grounds for trout and other species and unless fished much more intensively than at the time our survey was made, Nature will maintain as large a stock of fish as the food supply will support. In others, however, notably the high lakes having no tributary streams, a systematic planting of eyed eggs or fingerlings will be necessary to maintain fishing. Being essentially a wilderness park, every effort should be made to maintain the natural wild condition of the fish and the fishing.

H A T C H E R I E S

By Richard Paget, Editor, The Irish Angler

(Reprinted with permission from The Irish Angler, Vol. 1, No. 1, Spring, 1939)

IT IS VERY generally assumed by both salmon and trout anglers that the main problem of fishery development lies in increasing the stock of game fish in our waters. More often than not, the method, advocated for the attainment of this end, is the establishment of more and larger hatcheries. (1)

It is not proposed to discuss here whether or not there exists a widespread scarcity of salmon or trout in Eire. This is a matter, concerning which it is most difficult to prove anything definite. For the moment it will be assumed that such a dearth does, in actual fact, exist. Even so, it would be well if anglers were to pause in their insistent demands for hatcheries to review, closely, the whole problem of restocking.

Artificial propagation, as carried out in Eire at the present time, consists almost exclusively of the stripping of wild fish and of planting out the progeny of these shortly after the absorption of the yelk sac.

Are the results from this practice good enough to warrant its retension?

If they are not, must the whole system of artificial propagation be written down an economic failure, or can our present methods be so modified as to secure better returns for our outlay?

How do our methods compare with those of other countries?

It may sound a truism to state that the whole object of hatcheries is to increase the stock of "takable" fish of good quality, and that fry are not takable fish, but this is a fact that is often overlooked.

Our present practice would seem to be based on the assumptions that, in natural spawning, the period of greatest loss occurs between the extrusion of the eggs and the absorption of the yelk sac, and that the losses among hatchery bred fry, when turned out, will be less than those which would have occurred in Nature during the earlier stages. Taken collectively, recent investigations do not support either of these assumptions.

It would seem that, in the past, the early losses in natural spawning have often been greatly over-estimated. Calderwood (2) has for a long time emphasized this view. Fertilisation in natural spawning is probably higher and the losses among the fertilised ova in the natural redds, and among the alevins, are probably lower than has generally been estimated. This view is very strongly supported by the experiments of Dr. Foerster (3), Dr. Berry (4), and Mr. Derisley F. Hobbs (5). The position is thus tersely summed up in the "Salmon and Trout Magazine" (6): "What seems to come most clearly out of the investigation is that we must look to the fry and parr life of young salmon to find the cause of the great mortality between egg and migration stages." This is equally true as regards trout.

A striking example of one of the many dangers to which fry are exposed is shown in Dr. Berry's experiments for testing the relative efficiency of the natural and artificial methods. In these experiments the average survival rate was 19.5 per cent when eels were absent, but dropped to 3.4 per cent when they were present (4). Eels are among the worst if they are not the worst enemies of the young fry (7). Loach ("colleys") are nearly as bad, of these Dr. Berry writes: "I have examined enough of them to satisfy myself as to the justification of their evil reputation as fry destroyers." (8) It must be borne in mind that not only are eels and colleys particularly abundant in Eire but that, owing to the mildness of our climate and the relatively high winter temperature of our waters, the hibernation period of the eels is, almost certainly, very much curtailed or even absent.

Admittedly a higher proportion of fry can be obtained by artificial methods than would occur in natural spawning, but all this gain and more may be lost when the fry are liberated and there is reason to believe that artificially hatched fry are more vulnerable than those bred under natural conditions.

If the production of a greater proportion of adult fish to ova handled, than would have been attained by natural spawning, is the measure by which we should judge the efficiency of artificial propagation, and if it is necessary for economic or other reasons to plant out the artificially hatched fry immediately after the alevin stage - often a most disastrous procedure - then the wisest policy would seem to be the better protection of natural spawning.

If, however, we could modify, or add to, our present methods in such a way as to make it possible for us to carry the progeny of our hatcheries to a stage at which they could be regarded either as takable fish or as being safely past the most hazardous period of their life, and if we could do this at a reasonable cost and with an adequate survival rate, then hatcheries on an extensive scale would be fully justified.

Any proposed modification of our existing methods must therefore be examined in the light of the two essential provisos of cost and survival rates.

Hatchery costs are never easy to forecast and may vary considerably under different natural conditions, but it is worthy of note that, both in Europe (9) and America (10) a very large number of commercial fish-farms have been in existence for a long time, and as they continue to carry on the business it is only reasonable to suppose that they are making a profit and that it is possible to rear fish at a reasonable cost.

Survival rates from the different sources vary very considerably, but when acknowledged experts in England state that: "Most hatcheries reckon to have had a good year if they raise 5 per cent of their fry to the yearling stage," (7) while in a government publication in America it is stated as follows: "There are well authenticated instances of small lots of trout that have been carried through the first year with a total loss of less than 10 per cent from the time the eggs were taken. No doubt this represents an exceptional condition that cannot be duplicated on a large scale, but there is no reason why we should not try to approach this record," (11) the natural inference is that American methods are definitely superior to those in vogue in England. From a study of the data available there seems to be little doubt that it is so, but as most American hatchery work is carried out with rainbow and brook trout and only a relatively small proportion with brown trout, their results must be applied to our problems with some caution.

Indeed, it would be odd if hatchery practice in America were not immeasurably superior to that found in England and still further ahead of our own somewhat crude procedure. The success attained in each country is in direct proportion to the amount of research work carried on there, and in America there is an extensive and well organised programme of limnological and hatchery research work. State and Federal Governments operate a number of well equipped hatcheries for both experimental and restocking purposes.

It would, therefore, seem pertinent to consider some of the more outstanding features of American trout rearing practice.

The stripping and hatching procedure does not differ in any essential details from that in vogue with us but the dry method of impregnation is almost exclusively used. The breeders are, however, often taken from a selected brood stock. In view of the stress often laid on the value of breeding from wild parents it is interesting to note that American opinion is diverging from this view. It has been found that the progeny, even in the third generation, from carefully selected pedigree parents make far more rapid growth, show a much lower mortality rate, and a much higher egg production rate than is obtainable when wild or non-selected breeders are used. (11)

One of the main features of American trout rearing lies in the early transference of the fry to "race ways" or rearing "tubs" (11, 12). In race ways there is a very close approximation to natural conditions, for the bottom is usually lined with gravel and the depth and flow of water are such as normally exist in the stickles of brooks that are the natural habitat of the fry. This method is in use at a hatchery in England and the results are described as being "amazingly good."

Tubs are preferred in many cases owing to the greater economy in the amount of water used, the greater degree of control that can be exercised over the fry, and the very much larger number of fish per unit of area that can be raised in them. On the whole, the use of these tubs seems to provide about the best and most economical method of rearing fry that has as yet been devised.

The tubs really amount to no more than circular excavations in the ground with cement sides, 4 to 6 inches deep at the circumference and 15 to 20 inches deep at the centre and not more than 30 feet in diameter. The water enters, under fair pressure, tangentially so that all the water in the tub is kept constantly revolving until it reaches the centrally placed outlet. These tubs can be so constructed that they are self-cleaning. A tub of 15-foot diameter will carry 15,000 to 20,000 fry without overcrowding while Hewitt estimates that a 12-foot tub will carry 500 lbs. weight of trout. (13)

It is generally recommended that the tubs should be floored with gravel but arguments against this practice, based on hygienic grounds, seem worthy of consideration. (14) A very high survival rate is claimed for this method of trout rearing. It is in successful use at a private hatchery in England but there the growth rate is found to be lower than that obtained at a nearby hatchery using "raceways."

One of the principal factors in the economical rearing of trout lies in the cost of feeding, but it is impossible to consider this in detail here. It must suffice to say that this side of the problem has been the subject of very extensive research in America and Germany and that there is every reason to believe that we could provide, from home sources, all or very nearly all the food stuffs needed to make up a "balanced" trout diet at very reasonable cost.

It has only been possible to give here a bare outline of the hatchery problem as it exists in Eire today but it is hoped that in future issues of "The Irish Angler" some of the more important points outlined above will be dealt with in greater detail.

The whole matter is of so great practical importance to Irish salmon and trout anglers that it would seem to merit much closer and more critical investigation than it has hitherto received. One thing does stand out quite clearly and this is the urgent and immediate need for state financed and state controlled research work on the many fishery problems that confront us. At the same time it would seem to be well worth our while to give the closest consideration to the methods employed in other countries, especially to the methods employed in those countries where fish breeding seems to have reached a high level of efficiency.

With this in mind and in order to help such of our readers as may wish to make a more detailed study of the hatchery problem the literature referred to in this article is cited below.

REFERENCES

(1) Eire. (1933-1935) Report of the Commission on Inland Fisheries. P. No. 1818.
(2) Calderwood, W. L. (1930) Salmon and Sea Trout. London. (1931) Salmon Hatching and Salmon Migration. London.
(3) Foerster, R. E. Report No. 32 Biological Board of Canada.
(4) Berry, J. (1934-1937) Annual reports of Avon Biological Research Nos. 3, 4, and 5.
(5) Hobbs, D. F. New Zealand Fish Dep. Bul. No. 6.
(6) Salmon and Trout Magazine. (1938) 90.
(7) Towner Coston, H. E.; Pentelow, F.T.K.; Butcher, R. W. (1936) River Management. London.
(8) Berry, J. Fresh Water Development of Salmo salar. Unpublished thesis for Ph. D.
(9) Maitland, Sir J. R. (1887) History of Howietown. Stirling.
(10) U.S.A. (1931) Dep. of Commerce, Bur. of Fish. Fishery Circular No. 2.
(11) Davis, H. S. (1937) U.S.A. Dep. of Commerce, Bur. of Fish. Investigational Report No. 35.
(12) Leach, G. C. (1923) U.S.A. Dep. of Commerce, Bur. of Fish. Document No. 955.
(13) Hewitt, E. R. (1935) Trout Raising and Stocking. New York.
(14) Savage, J. (1936) Report on Effect of Gravel in Raceways. Transactions of American Fishery Society. Washington.

SOME EXPERIMENTS ON THE USE OF BEEF LIVER, SEAL MEAL SALMON MEAL AND APPLE FLOUR IN THE DIET OF YOUNG CHINOOK SALMON

By L. R. Donaldson
School of Fisheries, University of Washington

and Fred J. Foster
U. S. Bureau of Fisheries, Seattle, Wash.

A PART OF the program of evaluation studies of fish foods conducted in the joint investigations carried on at the University of Washington experimental hatchery, in cooperation with the U. S. Bureau of Fisheries, has been the testing by experimental feeding of meat and meal combinations. In the present series three meals were used: Seal meal made by the U. S. Bureau of Fisheries at its plant on the Pribilof Islands, salmon meal prepared from the spawned-out chum salmon at the Quilcene station of the Bureau, and apple flour prepared from the dried residue of cull apples.

Feeding Tests: - The feeding tests were carried on with young chinook salmon. Two thousand fish were placed in each lot at the start of the experiment. The experiment started as soon as the fish had completely absorbed their yolk sacs and was continued for 18 weeks. The water temperature during the experiment ranged from 45° F. to 60° F. with the average temperature at 51.1° F. Summaries of the results are given in Tables 1, 2, and 3 and Figure 1.

Four lots of fish were used in this series, with the control lot No. 1, receiving a diet of beef liver exclusively. The fish in this lot were fed ground beef liver once each day. No specified amount of food was allotted to the fish but great care was taken to give them all the food they would consume without waste.

The fish in lot No. 2 were fed a mixture of 40 per cent beef liver, 30 per cent seal meal and 30 per cent Quilcene salmon meal. The fish in this lot were also fed once a day but the total amount of the mixed diet fed was restricted to 35 per cent by weight of the total amount of liver fed the fish in lot No. 1. Previous experience had indicated that this reduced amount of the mixed diet would produce about the same rate of growth as would the liver diet.

The fish in lot No. 3 were fed a mixture of 40 per cent beef liver, 20 per cent apple flour, 20 per cent seal meal and 20 per cent salmon meal. In feeding this mixture the fish were given the amount of food they would consume without waste. This actually was equal to 45.43 per cent of the amount by weight of liver fed the No. 1 lot of fish. It was assumed in this case that the apple flour would furnish roughage and bulk in the diet and prevent overfeeding by the young fish.

The fish in lot No. 10 were fed a diet composed of a mixture of 40 per cent beef liver and 60 per cent salmon meal. These fish, like those in lot No. 2 were fed 35 per cent as much by weight of the mixed diet as the weight of liver fed the fish in lot No. 1.

In feeding the fish in lots Nos. 2, 3, and 10 a wire sieve was used to size the particles and scatter them above the water in the troughs containing the fish. The food mixtures as fed to these three lots of fish were of such a consistency that they could be easily and efficiently mixed in the blower type of mixer and fed to young fish with practically no waste.

Results: - The periodic average weights as given in Table 1 and Figure 1 indicate little variation in the rates of weight increases. The four diets, at the levels fed, and with the methods used, produced very uniform results.

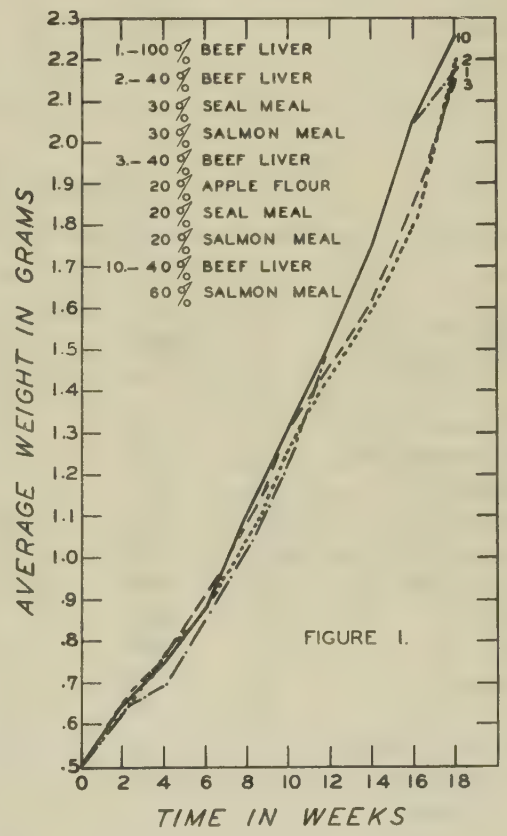


FIGURE 1.

During the 18 weeks the experimental feeding tests were in progress the liver fed lot (No.1) experienced the greatest mortality, with the death of 270 of the initial 2,000 fish, or 13.5 per cent. The fish in lot No. 2, fed a diet of 40 per cent liver, 30 per cent seal meal and 30 per cent salmon meal, suffered a mortality of 208 fish, while those in lot No. 10, fed the diet of 40 per cent liver and 60 per cent salmon meal had a mortality of 203 fish, or 10.2 per cent. Although the difference in mortality was not great, the minimum mortality was experienced by those fish fed diet No. 3, composed of 40 per cent liver, 20 per cent apple flour, 20 per cent seal meal, and 20 per cent salmon meal, where 182 fish (9.1 per cent) of the original 2,000 fish died during the experimental period.

The cost for the food to produce the increase in weight of the fish was very considerably less for those lots of fish fed the meat meal combinations as compared with those fish fed the liver diet, Table 3. At a cost of 5 cents a pound for liver, 4 cents a pound for salmon meal, 1 cent a pound for seal meal and 1 cent a pound for apple flour, the cost of the food to produce a pound of fish in the various lots was as follows:

Table 1. Average weight in grams of chinook salmon fingerlings based on samples weighed at two week intervals.

Date	Lot Numbers			
	1	2	3	10
January 30	.5	.5	.5	.5
February 13	.64	.63	.66	.65
February 27	.69	.77	.75	.75
March 13	.85	.88	.92	.88
March 27	1.02	1.04	1.08	1.11
April 10	1.23	1.27	1.31	1.31
April 24	1.51	1.44	1.45	1.51
May 8	1.74	1.59	1.61	1.74
May 22	2.05	1.80	1.85	2.05
June 5	2.17	2.19	2.16	2.25

Table 2. Cumulative mortality numbers

	Lot numbers			
	1	2	3	10
Initial No. of fish	2,000	2,000	2,000	2,000
February 13	99	102	87	72
February 27	151	144	116	121
March 13	186	157	132	150
March 27	213	164	141	163
April 10	224	170	148	177
April 24	242	185	154	186
May 8	251	196	165	192
May 22	260	204	167	198
June 5	270	208	182	203
No. of fish remaining alive	1,730	1,792	1,818	1,797

Lot No. 1 fed a diet of liver $0.18; lot No. 2 fed liver combined with seal meal and salmon meal $0.043; lot No. 3 fed liver combined with seal meal, salmon meal, and apple flour $0.051; and lot No. 10 fed liver and salmon meal $0.051.

Conclusions: - Young chinook salmon can be reared at an equivalent growth rate, with slightly less mortality and a considerable saving in food costs where up to 60 per cent of good meals replace part of the liver in the diet.

Table 3. Summary of experimental feeding tests with Chinook Salmon fingerlings at the University of Washington experimental hatchery.

Experiment started: January 30, 1939. Concluded: June 5, 1939. Average water temperature 51.1° F.

	Lot Numbers			
	1	2	3	10
Initial average length cms.	3.4	3.4	3.4	3.4
Average lgth. at report cms.	5.37	5.32	5.30	5.70
Per cent gain in length	57.9	56.5	55.9	67.6
Initial average wt. grams	.5	.5	.5	.5
Average wt. at report grams	2.17	2.19	2.16	2.25
Percentage gain in weight	334.	338.	332.	350.
Condition factor	1.40	1.45	1.45	1.21
Mortality number	270	208	182	203
Per cent mortality	13.5	10.4	9.1	10.2
Total wt. of foods fed (grams)	10,500	3,675	4,770	3,675
Efficiency factor	.28	.82	.63	.86
Lbs. of food to produce 1 lb. fish	3.57	1.22	1.59	1.16
Cost for food per lb. of fish	$ 0.18	0.043	0.051	0.051

Diet:

Lot No. 1 — 100% beef liver

Lot No. 2 — 40% beef liver, 30% seal meal, 30% salmon meal

Lot No. 3 — 40% beef liver, 20% apple flour, 20% seal meal, 20% salmon meal

Lot No. 10 — 40% beef liver, 60% salmon meal

Cost of foods used:

Beef liver	5¢	per lb.
Seal meal	1¢	"
Salmon meal	4¢	"
Apple flour	1¢	"

Salmon meal, available only in limited quantity, may be mixed with seal meal and fed to young chinook salmon without adverse effects.

The inclusion of apple flour in the diet serves very well as a bulk food in the combinations as used.

PERFECTION IN HATCHERY INTAKES

By A. H. Dinsmore
Superintendent, U. S. Fisheries Station, Berlin, N. H.

TO HATCHERY men who have spent night after night raking leaves, rubbish and anchor ice to maintain water flow, the possibility of an intake, self-cleaning and fool-proof, should be welcome news. The construction of such an intake at the St. Johnsbury, Vermont, station of the Bureau of Fisheries, converting what was undoubtedly the world's worst to what is perhaps the world's best, is an accomplished fact.

The principles involved have been worked out over a long period of years in stream diversion work at the National Forest, New Hampshire, station. Here, owing to the wide area covered by the work, it has been necessary to provide intakes requiring the minimum of human attention. These principles have been perfected in the recent construction at St. Johnsbury.

The Sleepers River is, of course, anything but a satisfactory hatchery water supply. Draining miles of cultivated land among the hills of several townships, its summer flow is very limited. A summer shower, however, may put it over its banks; spring and autumn floods are excessive, and it often runs full of slush ice at times of freezing temperatures. In spite of these difficulties, the station is producing most excellent landlocked salmon fingerlings and yearlings.

The original intake, like so many with which the writer has been familiar, could hardly have been designed to give more trouble if that had been the object in view. It consisted of a log crib dam, about 4 feet high, at the crest of a 30 foot fall. A masonry, breakwater, built well above freshet pitch, extended from the bank above, on the intake end, to the toe of the dam. The hatchery supply eddied around the lower end of this breakwater, between it and the crest of the dam, flowed back up inside the breakwater, in a sort of forebay, eddied again around the upper end of the intake bulkhead and passed to the intake pipes, at the lower end of the bulkhead. During periods of flood, yards on yards of silt, sand and gravel were deposited in the forebay eddies, often damming its entrance completely. It was frequently necessary to coffer dam the entrance from the river, drain the forebay and shovel tons of debris over the breakwater wall. Only a large storage reservoir, on the hillside below the dam, rendered the hatchery operation possible at such times.

Leaves and other trash, drawn into the forebay, passed to the intake screen, making frequent brushing necessary. Anchor ice always bothered when the air temperature dropped below 10° F, until the flowage above the dam froze completely over. This ice would freeze to the intake screen, which had to be brushed almost continuously.

The new intake has corrected all these difficulties. It consists of a weir of concrete construction, located near the head of flowage, which the old dam held. Only a few inches high, it extends from the east bank of the river across the channel to within about 15 feet of the west bank. Here it curves on a 10-foot radius and parallels the bank to a point about 140 feet below. As this weir wall maintains the same level throughout its entire length, at its lower end it is four feet high. The intake bulkhead, 6½ feet wide by 24 feet long, and tied to the west bank of the river, is spaced 4 feet from the lower end of the weir wall. The intervening space is fitted with flash boards and serves as a debris sluice for flushing the forebay. The walls of the intake bulkhead rise 2 feet above the top of the weir wall for flood protection. Two 8-inch pipe lines, for hatchery and pond system supply, take out of the lower end of this bulkhead.

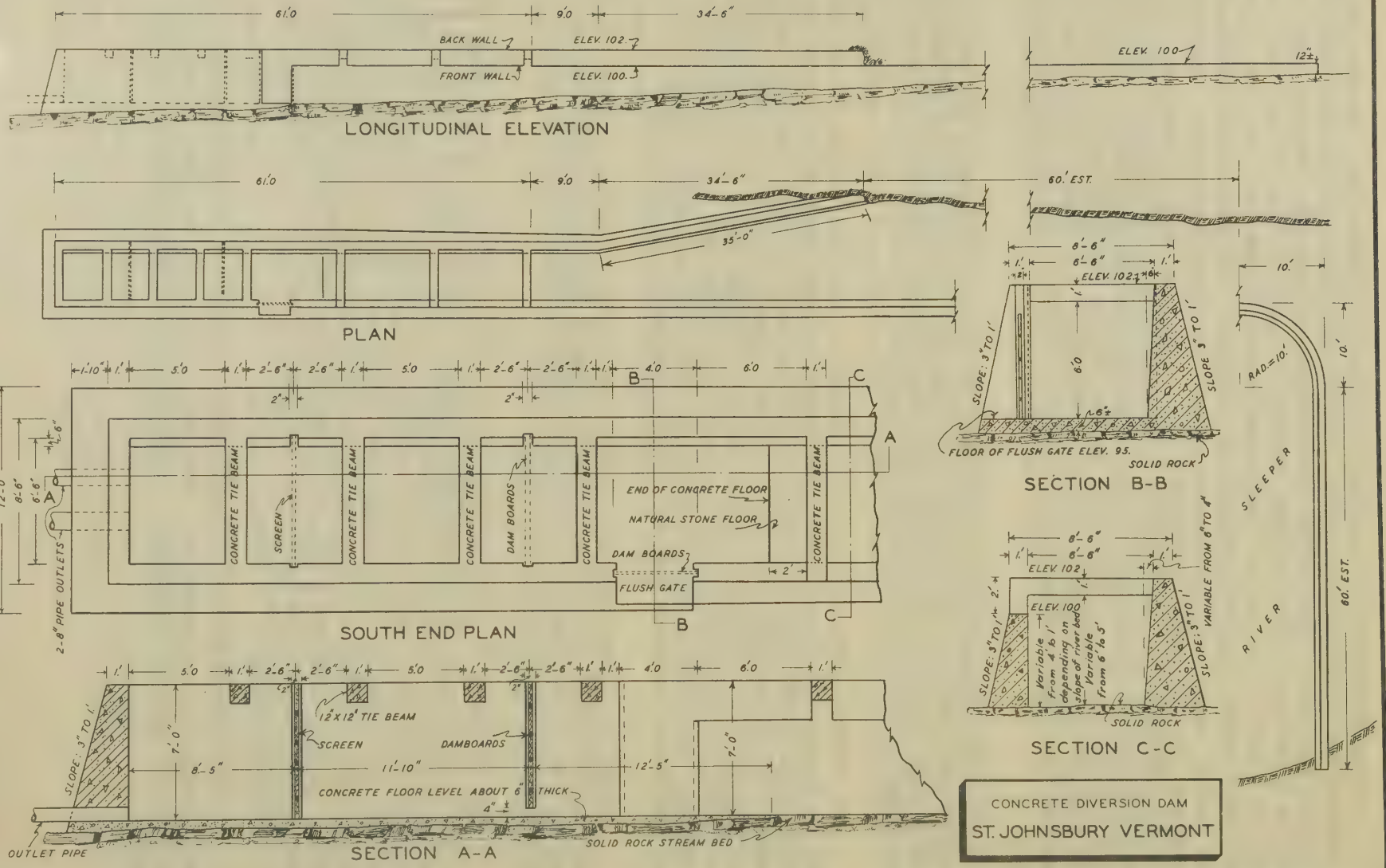
It will be noted that, including the 4-foot sluiceway, the weir provides approximately 200 feet of spillway and that the depth of water at the intake bulkhead is equal to the height of the weir wall, 4 feet, plus the depth of the flow over the spillway.

In action, during periods of low water, the entire flow of the river may be turned by the weir and flow inside the spillway wall to the intake pipes. In flood time only such water as the intake pipes may require passes the end of the spillway. As the volume of water, and consequently its velocity, is constantly lessened as it wastes over the long spillway, practically all heavy debris is dropped before the intake bulkhead is reached. By removing the flashboards, this can be quickly washed through the sluiceway whenever desired, almost entirely without labor.

Since the lower forebay, within the intake bulkhead, extends beyond the circumference of the gentle eddy, formed just below the lower end of the spillway, practically all the flotsam is drawn back and passes over the spillway and on down the river.

The intake was completed and put in operation during December 1938. To date the screen has never been brushed, neither debris nor anchor ice having collected upon it. In the history of the station, during any previous season, many hours of laborious work have been necessary in shoveling out the forebay. Since the new intake was put in commission, eight months ago, the forebay has been given one cleaning, requiring about two hours. It is expected that, in times of low water, when the intake is drawing heavily on the flow, and autumn leaves are falling, the screen will require some attention.

In the construction of this intake, we had the advantage of clean swept ledge for a foundation. But such a construction can be adapted to any kind of stream condition. Three important factors are to be kept in mind:


61'.0
9'.0
34'-6"
BACK WALL
ELEV. 102.
FRONT WALL
ELEV. 100.
LONGITUDINAL ELEVATION
ELEV. 100
12"±
61'.0
9'.0
34'-6"
60'. EST.
35'-0"
PLAN
8'-6"
6'-6"
1'.
1'.
ELEV. 102
6'.0
SLOPE: 3" TO 1'
SLOPE 3" TO 1'
6"±
FLOOR OF FLUSH GATE ELEV. 95.
SOLID ROCK
SECTION B-B
10'.
RAD.=10'.
10'
SLEEPER
RIVER
60'. EST.
1'-10"
1'.
5'.0
2'-6"
4'.0
6'.0
2"
12'-0"
8'-6"
6'-6"
6"
A
B
C
2-8" PIPE OUTLETS
CONCRETE TIE BEAM
SCREEN
DAM BOARDS
END OF CONCRETE FLOOR
NATURAL STONE FLOOR
DAM BOARDS
FLUSH GATE
2'
SOUTH END PLAN
8'-6"
6'-6"
ELEV. 102
ELEV. 100
SLOPE: 3" TO 1'
Variable from 4' to 1' depending on slope of river bed
Variable from 6' to 3'
SLOPE: 3" TO 1'
VARIABLE FROM 6" TO 4"
SOLID ROCK
SECTION C-C
SLOPE: 3" TO 1'
12"X12" TIE BEAM
SCREEN
DAMBOARDS
7'-0"
8'-5"
11'-10"
12'-5"
CONCRETE FLOOR LEVEL ABOUT 6" THICK
4" ±
OUTLET PIPE
SOLID ROCK STREAM BED
SECTION A-A
CONCRETE DIVERSION DAM
ST. JOHNSBURY VERMONT

(1) Length of spillway downstream. The longer this is, the less velocity of the current as it reaches the intake bulkhead and the greater the depth of water in the forebay.

(2) This depth of water in the forebay is extremely important. The greater this depth and the greater distance it extends above the intake screen the less trouble there will be from anchor ice. At St. Johnsbury this trouble seems to have been entirely eliminated.

(3) Distance of intake screen below the eddy formed as flood water reaches the lower end of the spillway. This screen should be well beyond the lower edge of the eddy. Then, if sufficient depth has been secured, there will, as at St. Johnsbury, be no perceptible current toward the screen, and the stronger current of the eddy will draw all flotsam back to the waste flow over the spillway.

TRANSPORTATION OF CHANNEL CATFISH EGGS AND FRY

By Charles L. Fuqua, Bozeman, Montana
and Hubert C. Topel, Miles City, Montana
U. S. Bureau of Fisheries

ALTHOUGH the channel catfish (Ictalurus punctatus) has been propagated successfully for several years by a few state game and fish departments, the writers are not familiar with any attempts to transport the eggs of this species of fish for a great distance. During the past spring J. M. Merritt of the Nebraska Department of Game, Forestation and Parks, very kindly offered to supply a number of the eggs and fry for transfer to the pondfish station at Miles City, Montana (operated by the Bureau of Fisheries in cooperation with the Montana Game and Fish Department) for use in developing a stock of fish of this species at that station. The problem of the transfer of eggs and fry for such a great distance as was necessary, inasmuch as the eggs had to be secured at Gretna, Nebraska, caused some worry on our part. However, Mr. Merritt, who has had considerable experience in the propagation of the species, was quite confident that the transfer could be made successfully; so we proceeded on June 20 to Gretna with a light sedan delivery truck for the purpose of making an attempt at such a transfer.

Upon our arrival at Gretna, we were still entirely ignorant of the best method to use in the transportation of the eggs. We had, however, taken with us a number of Fearnow fish transportation pails. Mr. Merritt had decided that the catfish spawns probably could be carried best by suspending them on woven wire baskets in 10-gallon fish transportation cans.

To conserve space in the truck (and probably from a biased partiality for the Bureau's pails) we decided to make use of three of the 10-gallon cans and two pails.

The wire baskets were made of 1/4 inch mesh galvanized hardware cloth and were suspended in the can just below the shoulder by means of wire hangers fastened over the outside of the neck of the can in such a manner as to allow the basket to sway with the movement of the water. The water level was placed at slightly above the shoulder. In the case of the pails the wire basket was made to fit inside the pail with about 1½ inches between the side of the pail and the basket. As in the case with the large cans, the wire basket was suspended so that it could swing from side to side. The top of the basket was placed slightly above the opening, in the side of the Fearnow pail. This action left the water level a little below the top edge of the basket. One larger sized spawn was placed in each 10-gallon can and two average sized spawns were placed in each of the pails. Eggs of all ages were used. Some were so far developed that they hatched enroute and others had only been removed from the nests the day before.

The water used was somewhat clearer than that being used at Gretna in the hatching of these fish. The temperature of the water in the cans at the time the eggs were placed in them was 66°. During the time the eggs were in transit, the water was allowed to reach a temperature of 78°, although for the most part it was held at 70°. During the entire trip, at hourly intervals, the egg masses were taken up in the hand and slightly shaken, or "pumped" (as it is more commonly called by the catfish culturist). It is doubtful if such action is necessary during the transportation of the eggs of this species, especially when clear water is used and the water in the cans is in motion. It was noted that the movement of the truck kept the wire baskets in constant motion and the eggs themselves were moving a great part of the time.

The distance from Gretna, Nebraska, to Miles City, Montana, is approximately 850 miles. The writers drove the entire distance without stopping other than for meals and gasoline. During the first several hours of the trip the weather was cool, but during a large part of the daylight hours the weather was quite warm and it was necessary to add ice from time to time in order to maintain an even temperature. The entire trip was made in approximately 20 hours and upon reaching the station at Miles City the eggs were placed directly in running water in hatching troughs.

In this experiment, seven egg masses or spawns, totaling approximately 40,000 eggs were transported with no apparent loss.

At the same time a number of channel catfish fry were also transported to Miles City from Gretna, Nebraska. They were from two different age lots. Two Fearnow pails were used for this purpose, one containing fry that had hatched the day previous to moving, and the other containing fry that had started to swim up. A total of 10,000 fry were carried in the

two cans. These fish were kept in water having an average temperature of approximately 65° with a range of 64° minimum to 70° maximum. The clear water was also used in the transportation of these fish as in the case of the eggs. They withstood the trip excellently and came through with little loss. The loss from the 5,000 day-old fry was 32 and from the 5,000 older fry only 11. There was no later loss of fry that might be charged to the transportation. Little difference could be noted between the two different age lots, but it is quite likely that the free swimming stage would prove to be the most satisfactory for transportation in cans.

The writers are quick to admit that their experience in the transportation of channel catfish eggs and fry has been limited to the one instance, and that there probably remains much to be learned relative to the matter. However, we do believe that we successfully carried out a very lengthy trip and that the methods used will operate successfully in any trip up to that length.

The Miles City station was not entirely prepared for the hatching of this species of fish, but by close attention and diligent care the eggs were hatched and the fry reared to date with a small loss. Necessity being known as the "mother of invention," we were forced to place the spawns in regular trout hatching troughs. Wire baskets similar to those ordinarily used in the propagation of the channel catfish were placed in use. Paddling was performed at first by hand inasmuch as such work could be easily carried on without extra cost. However, it was soon found that such an effort could not successfully take the place of the graduated movement set up by electric motors. It was therefore decided that the baskets should be placed in compartments set up in the hatching troughs by means of metal dams. This action forces the water up through each compartment. It was found that this method operated very successfully and that there was little or no fungus caused by rupture of the egg mass. Also, the water at the Miles City station, although coming from a small lake, is quite clear and may be more satisfactory than murky water inasmuch as it lessens the need for manipulation of the eggs, thus reducing the rupture of the egg mass and thereby lowering the development of fungus.

During the summer of 1940 the Miles City station expects to carry on further experiments relative to the propagation of this species of fish in the clearer, cooler waters found at the station. It is believed that experimentation with different types of food for use with this fish will also be worthwhile.

The methods of propagation of the channel catfish appears to be highly developed at the Gretna, Nebraska, station, and efforts will be made to adapt them to conditions found at Miles City.

The writers are indebted to Mr. Merritt for having made possible this experiment in the transportation of the eggs and fry of the channel catfish, and to the personnel of the Gretna hatchery for their assistance in preparing the eggs, fry, and equipment for transportation.

THE BULB SIPHON EGG PICKER

By Roger E. Burrows
U. S. Fisheries Station, Quilcene, Wash.

TO DEVELOP a method of egg picking that would combine the accuracy of the bulb method with the speed of the siphon method retaining the good and eliminating the bad points of each if possible.

EQUIPMENT

1 double ended bulb	$0.20
1 Pyroxilin tube, 3/8" inside diameter, 12" long	$0.20
6' rubber tubing, 7/16"	$0.90
2-1/2' copper tubing, 1/2"	$0.30
1 stop and waste valve, 1/2" inside diameter	$1.00
1 adapter copper fitting, 1/2"	$0.24
1 Mason jar and cap, 2 qt. size	$0.15
Total	$2.99

METHOD AND PROCEDURE

The principles underlying the operation of the bulb siphon egg picker are as follows: (1) The use of the bulb to expel good eggs that accidentally enter the picking tube, (2) the use of the siphon to keep the bulb clear obviating the necessity of emptying the bulb (see accompanying diagram).

The eggs are drawn into the Pyroxilin picking tube with the flow of the siphon. Good eggs may be ejected by a slight pressure on the bulb. The dead eggs follow the flow of the siphon into the jar where they are trapped. The water makes its way out through the valve and aspirator. A more detailed description of the various parts will be given in the following paragraphs.

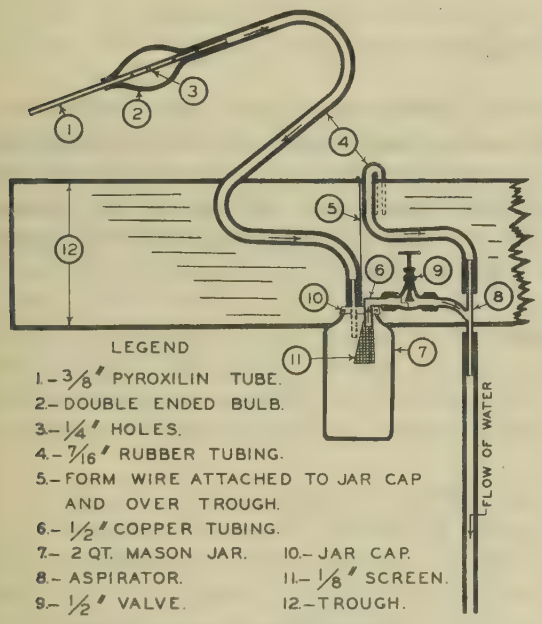
Pyroxilin picking tube: - This tube was drilled with three 1/4" holes in that portion which is inside the bulb. The advantage of Pyroxilin is that it is workable yet has every advantage of glass. This tubing may be secured from Dupont, Plastics Department, Wilmington, Delaware.

If Pyroxilin is not available in the size desired a short piece of copper tubing similarly drilled may be attached to a glass picking tube and be found to work satisfactorily. Let me emphasize that the tubing must extend through the bulb otherwise the eggs tend to hang up in the bulb itself as the pressure required for efficient operation of the tube is slight in the larger area of the bulb.

Rubber tubing: - This type of tubing should be heavy enough to resist kinking, yet flexible. I would recommend the type used on milking machines as it fulfills these qualifications (7/16" inside diameter by 13/16" outside diameter). The inside diameter of the tubing should be slightly larger than that of the picking tube, otherwise there will be a slight constriction at the joint and the eggs will tend to clog.

Double ended bulb: - The bulb was of the type used on beverage siphons. It was found to be ideal for the work.

Copper tubing: - Copper was selected because it is easily workable and takes solder well. Let me point out here that soldered joints in the jar cap are desired to give an airtight joint. Leakproof joints throughout materially aid in the efficient operation of the aspirator.



BULB SIPHON EGG PICKER
DIAGRAMATIC CROSS SECTION

Mason jar and cap: - A 2-quart Mason jar was used (1) the jar, cap, and rubber make a leakproof joint that can readily be broken or reformed, when it is necessary to dump eggs, (2) a larger size proves to be too bulky to move from basket to basket while a smaller will not hold a sufficient number of eggs, (a 2-quart jar will hold approximately 48 ounces of eggs and still permit free flow of water from the jar).

Screen: - A screen is used on the outlet from the jar as it prevents egg shucks and debris from clogging the valve.

Stop and waste valve: -Some type of valve is necessary to control the flow of water through the siphon to aid in picking and and to build up a back pressure for the bulb to operate against. A stop and waste was selected because fine adjustments may be made on the water flow and the waste plug will allow an increased flow through the siphon if stoppage occurs without tampering with the valve adjustment.

Aspirator: - The aspirator constructed of copper tubing may be dispensed with if desired but it maintains a continuous siphon allowing the picking tube to be out of water for considerably longer periods than would otherwise be permissible. It also aids materially in the picking of heavily fungused eggs as it prevents stoppage.

This picker was developed for use on chum salmon eggs averaging 3/10" in diameter. For that reason our tube sizes are necessarily large. However, I see no reason why it would not prove as efficient on trout eggs if the tubes were scaled down accordingly.

CONCLUSION

The bulb siphon egg picker is fast, accurate, and efficient. It is superior to the bulb method because a continuous flow of eggs is maintained without the necessity of emptying the bulb. It is superior to the siphon method because it is possible to eject good eggs after they have entered the picking tube. Due to controlled water flow and easy ejection of eggs it is easier to learn to operate than either of the other methods (an inexperienced man can learn to operate it with moderate efficiency in two or three days).

ACKNOWLEDGMENTS

Let me say that I take no credit for developing the principles behind the operation of this picker. How many men have contributed to it I do not know - undoubtedly there have been several. I would like here to make acknowledgment to Messrs. Charles Wrangham, Elmer Wood, Emery Ohr, and Marshall Thayer who have contributed immeasurably with ideas and suggestions for its more efficient operation.

NOTICE TO SUBSCRIBERS

There is a limited quantity of the earlier issues of the PROGRESSIVE FISH CULTURIST on hand, including Nos. 1-15, 17, 19, and 22-24. Anyone who wishes to procure these numbers of the publication may do so, as long as the supply lasts, by applying to the Bureau of Fisheries.

GOOD TOOLS HELP TO MAKE GOOD FISH CULTURISTS

By Robert Fortney
District Supervisor of Fisheries Operations
Michigan Department of Conservation

WE BELIEVE at our Paris hatchery that good tools are necessary in the operation of a trout hatchery.

The photograph shows six pieces of equipment that are used extensively in the rearing of trout from the egg stage up to adult size. Each piece of equipment is numbered and will be briefly described by number, as to its use and construction.

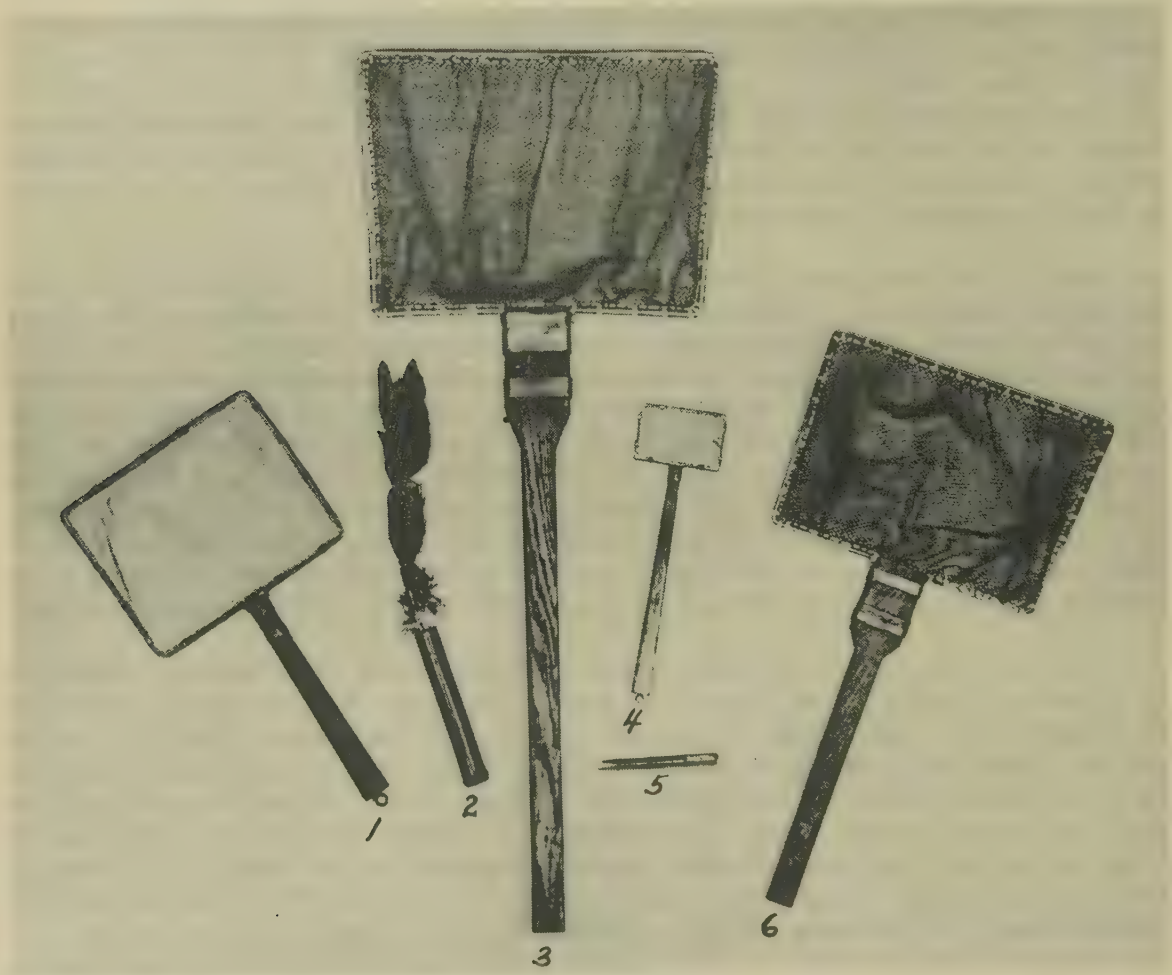
No. 1 is a fry scap with an oak handle 11" long. We use oak in constructing scap handled because of its strength and durability. The frame is 10-5/8" wide and 8-1/4" long. The wire in the main frame is brass and is hooked and wire wrapped to the handle. The wrapping wire is soldered to hold the ends and to make a smooth job. The diameter of the wire in the main frame is 1/8". A smaller brass wire 1/16" in diameter is then used just inside the main frame to fasten the bobbinet. This smaller wire is spaced just under 1/8" all the way around inside the main frame to allow a darning needle to pass between the wires. The smaller wire is held in place before soldering by copper clips 3/8" wide. Each clip is soldered to the wire and makes a stronger job than if solder is used alone.

No. 2 is a bundle of blue heron feathers tied together and inserted in a bamboo handle. We like blue heron feathers because they appear to be tougher and last longer in water than turkey feathers. The quills are not so large and are easier on baby fish. The handle is 7-1/4" long and is made from a bamboo fish pole. We picked out a pole large enough so that the hole is about 3/4" in diameter. Several handles may be secured from one pole. The handles should be shellacked and a couple of coats of spar varnish used to prevent checking. The bundle of feathers is tied large enough to fit snugly in the handle.

No. 3 is a scap used to handle fingerlings and trout up to adult size. A scap of this size is also used by the large planting truck units in scapping trout, bass, and bluegills from the tanks on the truck, into containers for planting and transfer. The handle is 28 inches long; 1½" by 1" at the handle, and 3" wide by 1" where the frame is fastened onto the handle. The frame is 17" wide on the front side and 15-3/8" wide on back or handle side. The length of the scap frame is 12". The material used in the frame is 3/8 round aluminum rod flattened as shown in photograph. Where flattened the frame is drilled in the center at intervals of 1-1/4" providing a 1/8" hole which allows the passage of a darning

needle to sew on the 1/4" mesh netting. Obviously the flattened and drilled area on the frame prevents wear on the twine. The aluminum rod is hooked and wire wrapped to the handle the same as scap No. 1.

No. 4 is a small fry scap with the fine bobbinet sewed on without any bag and is used to pick up dead fry out of the troughs. The handle is 10½" long. Both the outer and inner frame are made of 1/16" brass wire.



The inner frame is spaced a trifle over 1/16" from the outer frame and is spaced and held in place by means of copper clips and solder the same as scap No. 1. The frame is also hooked and wire wrapped to the handle.

No. 5 is a spring steel egg pick made out of 12" discarded Atkins hacksaw blades. The original holes are left intact and the steel is ground and shaped by means of a power emery wheel. The wood block which governs the width of the pick inside is 3/8" wide. The wood block is 3/8" square

and 1-7/16" long. The width of the finished prongs is 7/16" and they taper V-shaped back 1" from the 1/8" round ends. The tension of the pick can be governed by the length of the wooden block. The pick, as described is well balanced, almost unbreakable, and the tension just right for our use. The wooden block is riveted to the steel sides of the pick. The hacksaw blade was heated with a blow torch at the bending point and bent around a 3/8" rod. The finished length of the egg pick is 5-3/4". When the egg pick is finished the diameter of the metal 2/3 the way around the 1/8" holes is but 1/32". We painted the finished egg picks with two coats of aluminum paint.

No. 6 is a general purpose scap used to remove small fingerlings out of troughs and seines. The length of the handle is 16" and is 3/4" by 3/4" on the handle end. The handle is 2½" wide by 3/4" where the scap frame is fastened. The frame is made out of 1/4" round aluminum rod and is flattened and bored with 1/8" holes spaced 1¼" apart as shown in photograph. 1/4" netting is used. The front width of the scap is 13". The back width is 12-5/8". The length of the scap frame is 9½".

Scap frames Nos. 1, 3, and 4 are slightly curved from the back to the front. It is necessary to heat the metals at the bending point with a blow torch, for the scaps designated above. Where all of our scaps are fastened to the handles the side of the handle is grooved to allow the metal to come almost flush with the wood for wrapping. A hole is bored also, on each side of the handle, to receive the bent or hooked ends of the round metal frame. This makes a solid, rigid job which, when properly wrapped and soldered, lasts for years.

One long handled scap used in spawn taking operations is not shown in the photograph, but is built very similar to scap No. 3 with a five-foot round handle for catching large trout out of raceways and seines.

THE PROGRESSIVE FISH CULTURIST AND REORGANIZATION

THE PROGRESSIVE FISH CULTURIST presents visible evidence of government reorganization by appearing in new dress and under the seal of the United States Department of the Interior. With the transfer of the Bureau of Fisheries from the Department of Commerce to the Department of the Interior have come new problems of preparation and new methods of printing - hence the delay in issuing the July-October number. We hope that the changes will result, at least, in the improvement of the physical appearance of the journal.

NOTES ON CONTROL OF WEEDS IN PONDS

By Claude Lydell
District Superintendent of Fisheries Operations
Comstock Park, Michigan

WE HAVE AT this station one pond, No. 3, approximately 50 feet wide by 300 feet long, heavily infested with wild celery (Vallisneria spiralis) and have tried almost everything possible to get rid of it as during the last few years it has become so thick that it has been next to impossible to handle even adult fish without having to mow the pond several times a summer.

After exhausting all ideas of our own, I wrote Dr. A. S. Hazzard, Director of the Institute for Fisheries Research, Ann Arbor, Mich., and we received later on instructions which are contained in Leaflet No. 10, "Controlling Weeds with Chlorates," by W. C. Muencher. We purchased 100 pounds of sodium chlorate and upon receiving it we drew this pond as dry as possible and sprayed the weed with a solution of one pound of chlorate to one gallon of water and tried as closely as possible to apply the solution at the rate of 200 gallons per acre. Within 24 hours the leaves of the plants had turned brown and were dying down. I left them in this condition for three days and upon examination of the pond found that all plants about one inch from the ground were still green. I then put men in this pond and had them rake all dead matter off and sprayed it again, this time killing the plants to pond bottom (because of seepage I could not get pond bottom absolutely dry). This pond was left as dry as possible for seven days. As the plants seemed dead to all appearances we turned in the water and within about two weeks' time had one of the most beautiful ponds of wild celery I believe the eye of man ever looked upon, and the rest of the summer and fall how it did grow and thrive!

About this time we had adult breeders (small-mouthed bass) ready to start feeding and transferred them to this pond. It was only a short time until we had to start mowing out openings for feeding for the long leaves reached to the top of the water.

The sodium chlorate cost us $9.25 per 100 pounds and labor would amount to at least 1-1/2 days, although no accurate record was kept.

This vegetation became so dense and the mowing and cleaning such a job (the weed had to be scythed and raked out since it would not pull) that we conceived the idea of covering the bottom with something to stop the growth. We were ready to try most anything once and I purchased two rolls of cheap asphalt paper, containing 500 square feet per roll, at $1.25 per roll. This was cut into the required lengths and placed crossways of the pond where we wanted to feed; sand or mud was placed on the paper to hold it down until it became soaked. The paper was lapped so that nothing could get between the widths, and our troubles were over for the rest of the summer and fall.

In the fall after fish were transferred to wintering ponds and vegetation was being mowed and removed from ponds, this paper fell apart at a touch but vegetation underneath had not started and seemed dead. There is no question in my mind but that it will fill in again as long as the entire pond is not treated, but as an emergency control it worked fine. I have an idea that a commercial paper such as used by truck farmers might be purchased more cheaply, but the experiment must be carried further to see if by smothering for a season it will kill the roots or not. This was simply tried for a matter of two months but is food for thought.

In this same year (1938) we found where we had covered the Vallisneria in No. 3 pond it had killed out entirely, but this pond was so heavily infested, and we had only covered a strip about 4' x 100' through the center or side of the pond. This space stayed free of the plants until the latter part of the summer when young plants started up. But these were, no doubt, from the heavy growth along the edges. This plant had started to spread into No. 5 pond, and was in patches of from 2' to 5' in circumference and could be more easily handled, so we covered these patches and this fall (1938) there was no sign of the plant at the spots we had covered.

After covering these patches in Pond No. 5 in the summer of 1938 and finding no sign of the plant in the fall, a check was kept this summer (1939). This plant has not occurred in points where covering was made - except in only one instance and that was where the paper had become torn in covering and the plants came up through the tear. Great care has been used in placing the paper so no light gets through and so that the paper is not torn in any way.

This method may not be the answer to control in a large pond, but if certain undesirable weeds get in and are noticed in time, I find they can easily be kept from spreading by this method. We use a cheap tar paper, but a cheaper paper can no doubt be found when it is needed in quantities. We are still following this up as this plant has come up in other spots in this same pond, and this fall the same method will be used.

No. 3 pond which was so heavily infested, we covered last winter with some four to eight inches of fill dirt, and so far this summer the growth of Vallisneria is only around the edge of the pond where the plant was not covered. As soon as the fish are removed from this pond this fall, I intend to cover these places. As to whether in time the plant will come through the dirt covering is a question which we will have to answer at a later date.

A NARROW ESCAPE

(Editor's Note: During the winter of 1898-1899 Dr. Charles Minor Blackford was sent by the U. S. Commission of Fish and Fisheries to investigate an epidemic that had broken out among the brook trout fingerlings at the Northville, Michigan, station. While he was there his father sent him a Christmas box and the lines below give a description of the arrival of the box from the point of view of one of the young trout. The manuscript was found recently among old files.)

ALL THE SICK and ailing brook trout that resided in Pond "J,"
Were tremendously excited, and they showed it in their way.
They were huddled in a corner so that scarcely could a pin
Have been thrust into the water without wounding scale or fin.
Their food lay there neglected: Ground up liver had no charm,
Even Daphnia and Cyclops, for the time, were safe from harm;
As they hung with wrapt attention on the burning words that fell
From the gills of one bold fellow, and the wonders he could tell.

"I was swimming as my custom is, about the pond today,
When a dip-net slipped beneath me, and I was snatched away.
I was taken from the water, and was put into a pan
And was carried to the hatchery - think of it if you can!
I thought of all the happy days we spent while we were fry,
Before they put us in these ponds to sicken and to die,
But then they took me up the stairs where strange things met my sight,
The like of which I'd never seen since first I saw the light -
For that new man from Washington was seated in a chair,
With knives and gleaming bits of brass all scattered here and there
While in a jar, close by his side, a fearful sight to see,
Were many of our brethren, just as dead as dead can be:
The ones from time to time we've missed, as surely as my name
Is Salmo fontinalis,* you can bet they were the same.

"My opercula were trembling; my gill-rakers shook with fear;
I thought my doom was coming, and I saw no rescue near;
When I heard the bells a-jingling - the express came to the door,
And the pan that I was swimming in was set down on the floor.
A heavy box was then brought in and set down close to me,
And all the men came trooping in to see what it could be.
Mr. Clark, the superintendent, and the foreman, Mr. Root,
Came with gleaming wire cutters, and the others followed suit,
And they worked away like good ones, till the box was opened wide,
When they gathered 'round like children, just to see what was inside.

---

* Mitchell, Trans. Lit. and Phil. Soc., I, 1815, p. 435.

"But ere long all this was over, and they chanced to think of me,
And I trembled, for fish heaven then, I thought, I soon would see.
'Mr. Root,' called out the doctor, and before he could respond,
'I wish you'd take this other pan and throw it in a pond.'
The other pan was next to mine, and quicker than a flash,
I jumped from one to 'tother, and I never made a splash,
And the foreman didn't see me as he poured the water out,
And I felt so bright and happy that I almost gave a shout.

"Pond 'H' was quickly traversed, and its gate cleared with a bound,
And my way through iron piping to our happy home I found.
Now in spite of Streptococci, and our septicaemic doom,
I prefer to be among you than again get in that room."

Then the brook trout gravely scattered, and they found the liver's charm
And the Daphnia and Cyclops were no longer safe from harm -
But they thought of the adventures they had heard that very day,
And wished that man from Washington had kindly stayed away.

---Charles Minor Blackford, M.D.

NOTES AND NEWS

TROUT PLANTING IN ALASKAN LAKES

IN 1934 THE stream and lake survey parties of the U. S. Bureau of Fisheries working out of the biological field station at Little Port Walter, Alaska, made an interesting and important discovery in Sashin Lake on Baranof Island. During the course of the lake survey an abundant trout life was found existing in this large lake which is totally isolated by many high water falls from the trout and salmon runs that enter the lower tributaries of the watershed. Information obtained from people who had worked in the cannery at Little Port Walter revealed that in 1926 a number of the cannery employes collected small trout from the streams at Little Port Walter and carried them overland in cans to stock the lake. They inferred that up to that time Sashin Lake had been barren of any fish life and that the sole purpose of the undertaking was to establish a recreational fishery in the near vicinity. Upon further investigation it was definitely determined that only one species of trout was present in the lake; this being the very desirable rainbow trout (Salmo gairdnerii). All the lakes in the near vicinity which appear to possess similar fundamental characteristics were found barren of any fish life.

Facts concerning the presence of this large population of rainbow trout in Sashin Lake were turned over to the Forest Service, which has direct jurisdiction over the area. With the ever increasing number of sport fishermen in Alaska, more requests are pressed for the stocking of barren lakes and streams in all sections of the territory. Methods for handling and transporting rainbow trout stock from Sashin Lake to other watersheds were discussed and it was deemed advisable and the least expensive to attempt distribution by aeroplane.

On July 22, 1938, Mr. W. A. Chipperfield, directing the trout planting activities for the Forest Service, and Mr. S. J. Hutchinson, a biologist for the Bureau of Fisheries, undertook the first transplanting of trout with the aid of a plane. One thousand large rainbow trout from 8 to 16 inches long, and capable of maintaining themselves and spawning the first season after planting, had previously been selected and held in a confined area of the lake. Mr. Hutchinson studied the conditions to which the trout were subject and their reactions. It was evident that the survival was inversely proportional to the size of the fish and the number per can, and that far better results are forthcoming when each container carries only a few trout. From these observations only 15 trout, averaging 11 inches in length, and 8 gallons of water were placed in each can.

On the first trip out from Little Port Walter the plane carried six milk cans, 90 fish in all, the pilot and Mr. Hutchinson, who operated an automobile tire pump which forced air into each can to help maintain the oxygen supply in a limited water capacity. Immediately after taking off in the plane it was found that the trout became plane-sick, perhaps because of the change in altitude and undue vibrations. This sickness lasts for only a short period, after which the fish right themselves and become accustomed to the new environment. Temperature readings were taken at Sashin Lake (52°) during the flight (50.5°) and at the point of liberation (47°) thus indicating no extreme temperature changes were encountered during the whole procedure. This was the only lake planted that day due to the time consumed in preparing the first lot for shipment and the scientific checking of the experiment. The trip took 45 minutes by air to reach Blue Lake, Alaska, where the first consignment of adult trout were released under very satisfactory conditions.

With this experimental setup aboard the plane and favorable results from the first planting, word was radioed ahead to Juneau that a small number of trout would be flown that evening to Juneau and transferred to the commercial plane for a continued trip to Fairbanks, Alaska. Five of the original number of trout were still alive when the plane reached Fairbanks, thus indicating that long distance transplantings by plane are not impossible.

Mr. Chipperfield and the plane furnished by the Forest Service returned to Sashin Lake on July 24, and flew out a number of plantings to Deer Lake, Upper and Lower Brentwood Lakes, Davidof Lake, and Rezanof Lake. These plantings mark the first step toward a concentrated effort of trout rehabilitation in Southeastern Alaska and the development of new watersheds and areas which in the past have been only barren wastes of water.

T.V.A. FISHERY OPERATIONS

(Reprinted from The Forest Log, Department of Forestry Relations, Tennessee Valley Authority, Norris, Tenn.)

Brush Shelters for Fish

IN THE DEVELOPMENT of a fish management program designed to produce an annual yield commensurate with the needs of the fishing public, whether it be for sport or food, there are certain physical factors which play a role of primary importance. In order that fish may survive and eventually breed, an environment congenial to their needs is essential. The three most important factors of this enfironment are shelter, food, and breeding ground. Any one or two of these requirements are of little benefit unless the third is also available. In a reservoir such as Norris, wherein a drawdown of some 60 feet occurs annually leaving the shore lines exposed to the air for a period of months, the natural establishment of these three essential factors is problematical. Only one of these factors - the breeding ground - can be counted upon, and this only if the fluctuation of the water level is controlled within reasonable limits during the breeding season. The establishment of feeding grounds and protective shelter areas cannot be expected under natural conditions as they now exist in the reservoirs.

Therefore, in order that shelter and food may be made available to protect and feed the fish of Norris Reservoir, the Biological Readjustment Division has begun, under the direction of Dr. Eschmeyer, a series of demonstrations aimed to supply both of these essential needs. Large brush shelters from 20 to 40 feet in length are being constructed in certain regions, during the winter drawdown, under which has been placed a certain amount of triple and metaphosphate. Past experience indicates that it may be possible by this method to produce the micro-organisms in the water essential to the food of young fish, while the brush pile itself affords shelter to the feeding fish. Through the courtesy of the TVA Agricultural Relations Department, the Biological Readjustment Division has received 20 tons of phosphate to be used experimentally in an effort to determine the practicability of thus increasing fisheries production by artificial means in a large body of water. Reports on the effectiveness of this work will be made from time to time as data accumulate.

Fish Marking

During a favorable break in the weather in December, Doaks Creek Rearing Pond was drained, and the large-mouthed bass placed in it during the early summer were reclaimed and planted in Norris Reservoir. In order to ascertain the rate of growth of fish of known age, upon which knowledge is based an understanding of the problems associated with food supply

and other factors involved in the general health of the fish in the reservoir, 1,500 of those removed from Doaks Creek were "fin-clipped." One of the paired ventral fins up under the head of the fish was removed by clipping with scissors clear to the base, thus giving a definite mark which will forever identify that fish as a release from Doaks Creek pond at this time. Knowing, therefore, the age (six months) and the size of the fish (six to eight inches) at the time of their marking, and knowing also where these fish were released, further studies by the fish census method will determine the rate of growth and the dispersal of these 1,500 marked individuals. One phase of the fish census is made as these fish are caught and brought in at the various places around the reservoir.

Fish Salvage

Associated with the seasonal drawdown necessary to effectuate the flood control functions of Norris Reservoir, a considerable number of small isolated ponds result from the drop in level of the water in the reservoir. These depressions, located usually in what were originally fields or forest, are normally overgrown with brush and weeds, affording excellent shelter for small fish. As the water level drops it is customary for the fish to seek shelter in such places, with the result that many thousands of valuable food fish have become trapped as the reservoir waters receded.

During the last month four men supplied by Reservoir Property Management have been engaged in the removal of this shelter brush from ponds isolated by the water drawdown. By destroying such sheltering material, it is hoped that the large number of fish which otherwise would seek protection in such places will, due to the absence of brush, avoid being trapped by the drawdown. If this theory works in practice, a considerable amount of fish rescue work now necessary will be eliminated. In some cases it has been found possible to ditch and thus drain these ponds and, where feasible, this has been done. The idea underlying all of this work is to obviate the necessity of yearly seining in order to reclaim and rescue the valuable food fish which have been trapped. This effort will be reported upon from time to time.

PROGRESS IN ANTI-POLLUTION LEGISLATION

The Barkley Bill, which provides for the establishment of a Division of Stream Pollution Control in the U. S. Public Health Service, passed by the Senate on May 1, 1939 and favorably reported with minor amendments by the House Rivers and Harbors Committee on May 10, 1939, retains its place on the calendar and should receive consideration by the House of Representatives early in January when the Second Session of the Seventy-Sixth Congress convenes. Illinois was the fifth state to pass the compact bill providing for interstate cooperation in the control of stream pollution in the Ohio River Basin. Action by Kentucky and Pennsylvania is expected in 1940.

COMMENTS FROM OUR READERS

Gloves for Winter Use in Taking Bottom Samples

Editor, The Progressive Fish Culturist:

In a recent issue of the PROGRESSIVE FISH CULTURIST (No. 44) Dr. Leonard mentioned certain limitations in the use of the collapsible stream bottom sampler. Among them was mentioned the difficulty of operating the sampler at very low temperatures.

Two or three years ago I purchased two pairs of heavy white chemical gloves with five-inch gauntlets to which I had pieces of automobile tire inner tubing about 22 inches in length vulcanized. Previously I had used cotton, canvas, and rubberized canvas gloves which wore out quickly and were of little protective value during winter when collecting bottom samples is ordinarily a hardship. These gloves have been thoroughly tried out and can stand the wear on the tips of the fingers, which quickly wear out in ordinary gloves. The jobs of vulcanizing done on these gloves have been without flaw and today there has yet to appear a leak in them. Inner tubing was attached to only the righthand glove since this was the hand used by the writer and his assistant in taking samples.

The type of rubber glove referred to above is illustrated on page 880 of the Fisher Scientific Company's recent catalogue of "Modern Laboratory Appliances," item No. 14-101: Rubber gloves, heavy white, with gauntlet, cloth-lined with a five-inch gauntlet in sizes ten and eleven. Users of stream bottom samples will find that these gloves aid greatly in preventing hardships both in winter and summer.

Eugene W. Surber
U. S. Bureau of Fisheries
Leetown, West Virginia

Editor, The Progressive Fish Culturist:

Re: TIME Magazine's letters in July 10 issue, page 6, wherein Martin A. Miller describes the taking of the banana fish.

Besides getting a kick out of the description I visualized us "Progressive" fish culturists taking a cue from his account and trapping a few advanced methods of procedure on the average fish cultural station.

J. Q. McGee
U. S. Bureau of Fisheries
Welaka, Florida

REVIEWS

A BIOLOGICAL SURVEY OF THIRTY-ONE LAKES AND PONDS OF THE UPPER SACO RIVER AND SEBAGO LAKE DRAINAGE SYSTEMS IN MAINE

By Gerald P. Cooper, Fish Survey Report No. 2, Maine Department of Inland Fisheries and Game, August 1939

A BIOLOGICAL SURVEY OF THE FRESH WATERS OF LONG ISLAND

By Emmeline Moore, et al, Supplemental to Twenty-Eighth Annual Report, New York Conservation Department, 1938 (1939)

For many years scientists with elaborate equipment have been conducting exacting chemical, physical, and biological studies of our inland waters. They have published lengthy reports with detailed tables and analyses, always with the avowed intention of providing basic information to be applied in improving the management of fishery resources but often with the secret hope of impressing their professional colleagues. For many years fish and game commissions and conservation departments have been providing financial support for these studies in the fond belief that science will some day solve their problems and with the patient hope that something practical will develop to justify the expenditure of public funds. Seldom have we seen reports of such surveys that satisfy so abundantly the double aim of investigators and the single aim of administrators as the two reports under consideration.

The first of these is the second report in a series of biological surveys of lakes and ponds in the State of Maine and the second is the twelfth in a similar series designed to cover all the watersheds in the State of New York. Perhaps the adequacy of the drainage basin inventories conducted in the latter state for the previous 10 years was the basis for outlining a nearly equally ambitious program of stream and lake surveys in the State of Maine. Special attention to both reports is given here not only to acquaint our readers with a technique of fishery management, but with the hope of interesting other states in laying out and carrying through similar systems of physical and biological inventories of their aquatic resources that will pay large dividends to the people in economies of operation and in larger returns on the investments for fishery conservation.

Dr. Cooper's report presents the results of a biological survey of lakes and ponds of the upper Saco River and Sebago Lake drainage system of Maine. The work was conducted during the summer of 1938 by the Maine Department of Inland Fisheries and Game in cooperation with the Zoology Department of the University of Maine, where the author has been employed as instructor since his graduation from the University of Michigan. The survey covered a considerable portion of the great concentration of ponds, as they are called in New England, which exist in the extreme southwestern part of the state.

The purpose of the survey was to gather as much information as possible concerning the suitability of each lake and pond to support trout and salmon, but the work was sufficiently intensive not only to indicate whether the ponds would support salmon at all, but to calculate with a fair degree of accuracy the number of fish which should be stocked each year. An additional object of the survey was to make other recommendations on the proper management of lakes and streams with reference to species of warm water fishes, the control of warm water species in trout and salmon ponds, the planting of food organisms, and the desirability of changes in present fisheries legislation.

The author states that the results of the survey have a very practical application and this is abundantly borne out throughout the 147 pages of text and figures, particularly in the condensed descriptions of each of the ponds surveyed with specific recommendations for stocking.

As the background for understanding the detailed data of the survey consisting of tables presenting description of ponds, water analyses, depth, temperature and oxygen data, abundance of plankton, bottom food organisms and fish populations, the author presents a very readable account of the characteristics of lakes, which while relating to conditions in Maine, apply in general over the whole northern United States. This section is a summary of general information well known to limnologists, but it is stated so clearly that everyone concerned with the practical aspects of fishery management would profit by studying it.

In a correspondingly clear and concise manner the author in the following sections summarizes the requirements of trout and salmon and other game fishes, discussing under the headings of the various important game fish species found in the Maine lakes such items as water temperature, oxygen, food supply, spawning grounds, and stream habitats. The suitability of the water in lakes and ponds surveyed for trout and salmon comprise the main body of the report, together with tables of detailed observations. The following section dealing with the fish populations of the lakes contains much information of both practical and theoretical interest. After a brief theoretical description of the competition between game species, the author proposes a simple numerical figure to express the amount of competition of warm water game fishes against trout and salmon. This competition factor is made use of in the subsequent chapter dealing with the stocking policy for trout, salmon and bass, and a proposed

planting table based on the number of six-inch fish per acre is presented which also includes the factors of fishing intensity, competition, food, and spawning facilities.

One of the most interesting results of the survey is the presentation of the necessity of budgeting hatchery production for the adequate stocking of the 31 lakes and ponds covered by the survey. The total number of trout and salmon recommended for stocking for this group as a whole are as follows:

200,000	six inch landlocked salmon for Sebago Lake
34,900	six inch landlocked salmon for four other lakes
24,750	six inch brook trout for nine lakes
30,800	six inch chinook salmon for Long Lake
14,000	two inch Togue (lake trout) for Crystal Lake

This represents a total annual stocking of 304,450 fish. But this same group of 31 lakes and ponds received an average yearly stocking of only 200,780 fish of all sizes during the five year period from July 1, 1933 to June 30, 1938, as shown by the following tabulation.

Sebago Lake:

40,000	two to four inch landlocked salmon
35,000	four to six inch landlocked salmon
17,000	"mature" (over six inches) landlocked salmon
12,000	four to six inch brook trout
80	"mature" brook trout
2,000	four year old brook trout
106,080	total for Sebago Lake

All Other Lakes:

4,000	landlocked salmon fry
7,200	two to four inch landlocked salmon
27,600	four to six inch landlocked salmon
3,300	"mature" landlocked salmon
21,200	four to six inch brook trout
7,900	"mature" brook trout
5,000	"mature" brown trout
8,900	four to six inch chinook salmon
6,000	"mature" chinook salmon
2,000	lake trout fry
1,600	four to six inch trout
94,700	total for other lakes

It follows from these recommendations that it will be necessary either for the hatcheries of Maine to increase their output, particularly to meet the demand for greater supplies of salmon in Sebago Lake or to transfer fish which would otherwise be planted in other waters. The following comment is made by the author in this connection: "The present

stocking recommendations introduce several important changes in distribution of trout and salmon among the various lakes and ponds. Five ponds, which have been stocked heavily with trout or salmon during the past five years, were found to be unsuitable for these fishes; these ponds are Wood Pond, Highland Lake, Hutchinson Pond, Thomas Pond, and Rattlesnake Pond or Crescent Lake. A considerable increase in amount of stocking is recommended for some ponds, and a considerable decrease for others."

Space will not permit a detailed review of other fish management policies for the lakes and ponds surveyed, but they are well worthy of careful study, for the problems in Maine are by no means unique.

The report on the biological survey of the fresh waters of Long Island presents perhaps less startling results than the one on Maine, since it covers a restricted area which despite heavy demand is relatively unproductive. It is, however, the last report in a long series of surveys undertaken on a most ambitious scale and represents the culmination of a far-seeing project rather than the initiation of one. While Dr. Moore and collaborators have spent less time than Dr. Cooper in presenting the general background and justification for the details of their findings, which have been covered at great length in earlier reports, the results are just as significant and the facts just as pertinent to a balanced system of fishery management.

One item of particular interest stands out. Discussing the table of fish planting conducted in the Long Island area in the past 10 years it is noted that, exclusive of marine species, 15,965,082 young fish have been distributed in these waters, of which 15,000,000 are pike perch. This is a relatively low rate of stocking compared with the lower Hudson River, the nearest upstate watershed, and is also low in relation to the area of water. "Furthermore," Dr. Moore states, "the survey took no pike perch anywhere in the area and except for stray specimens from Lake Ronkonkoma none was reported by fishermen." The author continues with the following significant statement:

"Among the warm-water species stocked it is of special interest to note that although more than eight times as many smallmouth as largemouth bass have been planted during the last 10 years, actual bass fishing in the area is almost entirely for largemouth. This illustrates the fact that stocking with the sizes and numbers of warm-water species available is not generally an essential factor controlling fishing. On the contrary, generally little or no correlation is apparent between the fishing afforded by the warm-water ponds and their stocking history during the past 10 years. One may conclude from this that natural spawning of resident species is adequate in most cases to supply what fish the various warm-water environments will maintain. As recorded in other survey areas, there are in this table examples of unfortunately heterogeneous planting. In Hawley Lake smallmouth bass and yellow perch have been stocked as well as all three species of trout. In Belmont Lake, similarly, both trout and warm-water species have been stocked. Seldom is it wise to attempt encouragement of both trout and warm-water species in the same water.

"It was concluded by the survey that generally for Long Island waters stocking is not the factor limiting fishing, but that production is held down rather by low natural fertility. This unfavorable condition for growth especially affects the warm-water species for which, in most cases, only young fish are available for planting. It is possible to produce trout fishing without depending upon the natural waters to produce it provided sufficient numbers are available for stocking at legal sizes."

In presenting these lengthy comments it is hoped that they will only whet the reader's appetite to study the reports in full. They doubtless may be obtained from the state departments concerned. If a detailed examination of the waters of a state reveals only the useless stocking of unproductive waters and thereby leads to economies in that direction, the cost of such a survey will be repaid many times within a few years.

Elmer Higgins.

PROPAGATION OF BAIT AND FORAGE FISH

THE PROBLEM. Dwindling minnow supplies in natural waters bring complaints from two sources: (1) Bait dealers who go far afield and seine long hours to collect supplies of bait for anglers, yet often return with a small catch of inferior quality minnows; (2) Anglers who find that game fish are scarce where waters are poor in natural food, in spite of frequent hatchery plants.

THE SOLUTION. Propagation of minnows by bait dealers and fish culturists relieves the drain on streams and lakes and assures a dependable supply of forage fish for use in bass ponds or for sale as bait. The recent Bureau of Fisheries publication, PROPAGATION OF BAIT AND FORAGE FISH, by Henry C. Markus, gives practical information on how to construct and manage minnow ponds, how to choose the minnow best suited to local conditions, and how to provide proper spawning facilities for the different types of minnows. Pond production ranges from 35,000 to 200,000 minnows per acre according to the species.

Fishery Circular No. 28, PROPAGATION OF BAIT AND FORAGE FISH, is a useful handbook for all who are interested in the culture of minnows. A copy may be obtained for 5 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C.